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Arizona Corporation Commission
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January 6, 2016

RE: COMMISSION'S INVESTIGATION OF VALUE AND COST OF DISTRIBUTED GENERATION
Docket No.: E-00000J-14-0023

Dear Commissioners and Interested Parties:

In my December 22, 2015 letter, "*Core Cost and Benefit Categories*" *(personal communication, 2015)* as defined by Timothy James from the L. William Seidman Research Institute at the W. P. Carey School of Business at ASU was used as a reference. Because the document was omitted from the letter when docketed, it is being provided to you now.

Sincerely,

Shannon Whiteaker
Executive Assistant
Arizona Corporation Commission

Docketed January 6, 2016
Mailed January 6, 2016 to the Service List in Docket No. E-00000J-14-0023

THE VALUE OF DISTRIBUTED SOLAR GENERATION

Tim James

December 10, 2015

Costs and Benefits Included in Recent Studies

- The cost to the customer of purchasing or leasing a solar system, its installation, and O&M
- The cost (including administrative costs) to the utility of any DSG incentive paid
- The cost to the utility of integrating DSG
- Utility revenue cost – resulting from a fall in demand for central station generation
- Avoided energy generation or fuel costs
- Avoided generation capacity costs
- Energy line loss savings
- Avoided regional and in-state transmission capacity costs
- Avoided regional and in-state distribution capacity costs
- Fuel/natural gas price hedging benefit – attributed to DSG associated with a reduced need to mitigate price volatility risks associated with wholesale energy and/or natural gas prices
- Market price reduction – associated with a reduction in wholesale energy and/or natural gas prices resulting from a utility's reduced demand for electricity as a consequence of more DSG, and its potential dampening effect on energy prices
- Environmental emissions and air pollutants value
- System reliability and resilience – attributed to the characteristics of DSG as a back-up power source to overcome outages, a potential diversifier of a utility's generation portfolio, and/or its impacts on ancillary grid services
- Water usage
- Land impacts
- Economic development benefits
- Disaster recovery benefits – associated with the continued availability of electricity in weather-related emergencies
- Avoided renewables (RPS or RES) benefit
- O&M cost savings – generally counted as part of the avoided fuel cost and avoided generation capacity cost categories though could be in excess of these
- Long term societal value – attributed to the magnitude of all the benefits listed if the economic life of a DSG system extends beyond the number of years originally assumed in the assessment

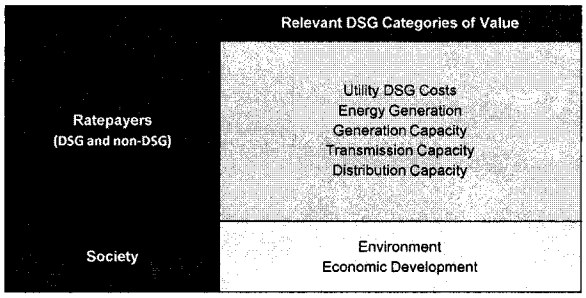
7 Core Cost and Benefit Categories

- Utility DSG Costs - DSG Incentive Program and System Integration Costs; Utility Revenue Losses
- Energy Generation Savings
- Generation Capacity Savings
- Transmission Capacity Savings
- Distribution Capacity Savings
- Environmental Benefits
- Economic Development Benefits

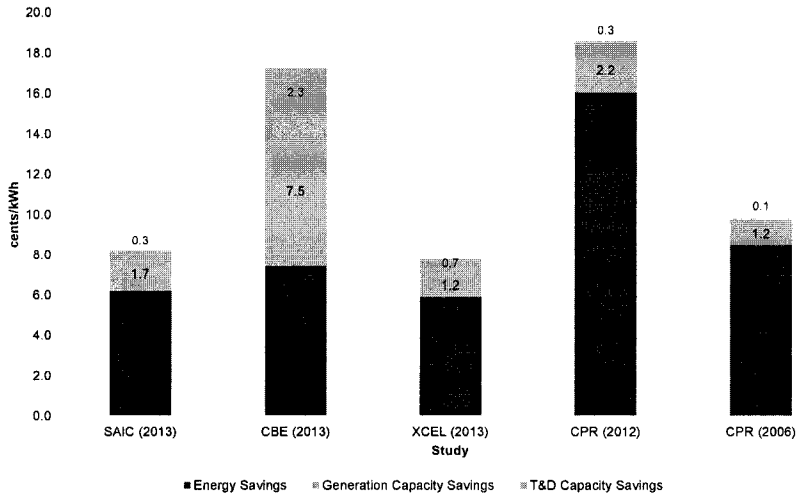
7 Categories of DSG C&Bs

	DSG Program Costs and Revenue	Energy Generation	Generation Capacity	Transmission Capacity	Distribution Capacity	Environmental	Economic Development
DSG system costs including O&M	X						
Utility incentive and program admin costs	X						
DSG solar integration costs	X		X	X	X		
Utility revenue impact	X						
Avoided energy generation costs		X					
Avoided generation capacity costs			X				
The potential for energy loss savings		X	X	X	X		
Avoided region/instate transmission capacity				X			
Avoided regional/instate distribution capacity					X		
Fuel/natural gas price hedging benefit		X					
Market price reduction		X					
Emissions and air pollutants value						X	
System reliability and resilience			X	X	X		
Water usage		X				X	
Land impacts						X	
Economic development benefits							X
Avoided renewables benefit		X	X	X	X		
O&M cost savings		X					
Long term societal value		X	X	X	X	X	X

Ratepayers and Society



Comparison of Recent Valuations



General

- **Economic Life**
  - Calculation of costs and benefits should extend over same period as system availability
- **Levelized Costs**
  - Presentation of costs and benefits should occur in a levelized cost framework with appropriate discounting over the period of the valuation
- **Mix and Penetration**
  - A valuation of DSG should be carried out on an appropriate mix of DSG system types appropriate to the location considered
  - Valuations of DSG should involve an appropriate method of forecasting of the degree of penetration over the economic life

Scale of DSG Penetration

- Low levels of solar penetration (particularly in the short run) will have a negligible effect in terms of system capacity benefits
- Benefits only accrue with large-scale DSG penetration
- Simply grossing up the analyzed effects of small-scale DSG systems fails to take into account the way in which a utility's generation and its T&D system will mutate over time to accommodate the DSG
- Justifies a "lumpy" approach in valuing solar deployment modeling large penetrations to quantify the value of DSG

Average versus Marginal Valuations of Costs and Benefits

- *Costs* - each kWh of distributed solar fed back into the utility system is valued at the tariff applicable to consumption for the consumer - Essentially, this is an *average* valuation since the tariff is set through volumetric pricing
- B*enefits* of each kWh of DSG fed back into the utility system are generally assessed at their *marginal* value
- Small-scale DSG additions can potentially offer relatively larger benefits when the level of penetration is low by significantly reducing peak load
- Large-scale additions with already high levels of solar penetration do not bestow the same high marginal benefits – that is, DSG suffers from significant diminishing marginal benefits (with declining utility marginal costs)
- Any appraisal of DSG that considers small-scale additions and values them using utility marginal costs and then grosses up the effects for high penetrations is therefore subject to upward bias

Utility DSG Costs

- Cost (including administrative costs) to the utility of any DSG incentive paid
  - Installation costs privately incurred by the DSG customer do not apply to a general ratepayer perspective
- Cost to the utility of integrating the DSG into the grid
  - Ideally calculated using a cost-based engineering approach that takes into account both the small-scale effects at feeder (distribution system) level and the *cumulative* impacts of DSG *system-wide* on transmission and generation
- The utility's loss of revenue resulting from a fall in demand for central station generation electricity
  - Should be assessed by valuing reductions in electricity consumption at the *appropriate* utility price per kWh

Generation

- Fuel savings, Transmission and distribution line losses
  - Benefits of reductions in fuel usage, variable O&M and T&D line losses require a generation dispatch simulation tool - for example, ProSym or PROMOD
- Potential fuel price hedge benefit and Market price reductions
  - Fuel price hedge - there is no easy way to account for the disconnect between the length of a futures contract and the life time of a DSG system
  - Market price - limit to how much the wholesale prices can fall and supply/demand balances can re-correct and any capacity overhang reduce
- Avoided RPS costs
  - Should be assessed by calculating the reduction in the size of the required utility renewable portfolio and then calculating the associated savings

Generation Capacity

- Capacity
  - Reliability is a key consideration when assessing the system capacity value of DSG
  - Effects from a capacity perspective are long-term/higher levels of penetration
  - Assess benefits of DSG on capacity/avoided renewable generation capacity on a yearly basis using an engineering/cost approach
  - Credit for system capacity reductions involving *partial* avoidance of new generating capacity should be assessed at appropriate capacity market rates (or comparable proxies)
- Security
  - Security enhancement benefits should not be assessed as they are currently defined because they do not accrue to *all* ratepayers

Transmission Capacity

- Dependent on:
  - Location-specific capital expansion plans
  - Penetration and dispersion of the DSG
  - The coincidence of DSG and local demand
- Short-term, at least, the transmission capacity benefit of DSG is negligible as the utility's transmission plans are already set - almost all the central costs remain
- Appropriate way to assess the benefits of DSG in terms of transmission capacity is on a year-by-year basis using an engineering/cost approach, deferring and/or avoiding transmission capital expenditure in a planning framework

Distribution Capacity

- Considerations:
  - Sending excess power back to a utility grid (without cost) leads to a cost shift against non-DSG ratepayers
  - In extreme a DSG customer that *only* consumes the electricity that they locally generate will make no contribution to the cost of a distribution system - serving as a back-up source for accessing central station generation
  - The cost of upgrading distribution systems to enable DSG customers to send excess power back to the grid and/or allowing a DSG customer's neighbors to benefit from any surplus generation
- Appropriate way to assess the benefits of DSG in terms of distribution capacity is on a year-by-year basis, using an engineering/cost approach to deferred and/or avoided transmission capital expenditure in a planning framework at a feeder level
- Extremely costly and time-consuming so an acceptable compromise is to examine representative feeders and aggregate up any assessed benefits

Lessons for Valuation

- Stakeholder perspective
- Appropriate mix of DSG systems appropriate to the location considered
- Good methods of forecasting of the degree of solar penetration over timescale
- Care grossing up small-scale additions and valuations using utility marginal costs
- Measure T&D and capacity benefits using a cost-based engineering (planning) approach on a year-by-year (and cumulative) basis
- Benefits of reductions in fuel usage, variable O&M and T&D line losses require a good generation dispatch simulation tool - ProSym or PROMOD

Some Musings

- Objective is to reduce emissions – increase renewables (solar)
- NEMs or FITs have complex problems
- If the private benefits of solar are as great as calculated by some, why are there still utilities?
- Why not use carbon taxes and let people and markets adapt?

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